

Title

ENHANCED AIRFLOW CONDITIONING SYSTEM FOR REMOVABLE DATA
STORAGE CARTRIDGE

Cross Reference to Related Applications

[0001] This application claims priority from United States Provisional Patent
Application 60/426,981, filed November 15, 2002.

Federal Research Statement

[0002] (Not applicable)

Background of Invention

[0003] This invention relates to storage cartridges removably installable into a
disk drive.

[0004] A typical disk drive for receiving removable storage cartridges has an
actuator that carries read/write heads for communicating with a disk. Linear
actuators translate back and forth along a radial axis of the disk. Rotary
actuators usually consist of a structural arm that pivots on a voice coil motor and
carries read/write heads on a distal end.

[0005] When the storage cartridge is not in use, it has a casing surrounding a
storage disk which provides protection against dust or contaminants. However
when the disk is installed in a drive and accelerated to high speeds for fast
access by read/write heads in the drive, an incredible amount of air turbulence is
created. Therefore, protection and stabilization of the storage medium on the
disk becomes a very serious problem. Some improvements have been obtained
by incorporating an inner seal around portions of the periphery of the storage
cartridge. See, for example United States Patent Application Serial No.
09/346,485 entitled A SHUTTERLESS DATA RECORDING CARTRIDGE AND
SEAL, which is incorporated herein by reference. See also United States Patent
6,466,406 entitled DATA STORAGE CARTRIDGE HAVING ONE OR MORE

SURFACE RECESSES FOR IMPROVED INTERNAL AIR CIRCULATION, which is incorporated herein by reference.

[0006] Higher storage density on disk storage media has made the prevention and control of dust infiltration a very important factor. Also undesirable particles dislodged or otherwise transported through the air because of the various moving parts within the cartridge and associated drive may abrade and corrupt the storage media.

[0007] United States Patent 4,885,652 to Leonard, et al. discloses a generally square disk cartridge for a recording disk includes at least one air filter in a corner of the cartridge and a circular rib adjacent the disk and between the disk and the filter. The cartridge may also include a radial rib connected to the circular rib to enhance air flow to the filter. Air filters may be located in each of the corners of the cartridge with associated circular and radial ribs to induce air flow to each filter.

[0008] United States Patent 4,969,061 to Patterson et al. discloses a cartridge with a flexible storage disk that rotates against a Bernoulli surface with a passage in communication with a differential pressure region such that air moves through the passage. A filter is positioned in the passage to remove particulate materials from the air.

[0009] United States Patent 5,615,070 to Bordes discloses a cartridge disk that includes an electrostatic filter in the shell enclosure that is strategically placed to clean the air circulated within the cartridge disk during operation. One part of the filter is placed in an air inlet centrally-mounted in the cover piece of the shell enclosure near a rotation axis of the hard disk platter. A second part of the filter is positioned in an outlet port and sandwiched between the cover piece and the base piece of the shell enclosure.

[0010] United States Patent 6,466,406 to Hall discloses a data-storage cartridge comprises an outer shell having an inner surface with a recess is formed in the inner surface. The recess extends from near the outer peripheral edge of the

data-storage medium to near the hub. A liner is attached to the inner surface of the outer shell so that the liner covers a portion of the recess so that the liner and the recess form a passage for circulating air between the outer peripheral edge and the hub of the data-storage medium. A filter may be placed at either end of the passage or in the passage.

Summary of Invention

[0011] The invention provides improved protection from air-transported particles such as dust, excessive moisture, contaminants, and the like by filtering or otherwise conditioning the airflow without interfering with the movement of a read/write head actuator or the rotation of a storage disk installed in a disk drive.

Brief Description of Drawings

[0012] FIG. 1A shows a perspective view of an embodiment of the invention in a removable storage cartridge constructed to receive a linear actuator.

[0013] FIG. 1B is a top planar view of the removable storage cartridge of FIG. 1A with certain storage disk components shown in phantom.

[0014] FIG. 2 shows another embodiment of the invention in a removable storage cartridge constructed to receive a rotary actuator.

[0015] FIG. 3 is an embodiment of the invention showing a partially cutaway view of a drive having a storage disk inserted therein, with a rotary actuator in loaded position and also showing in phantom the rotary actuator in unloaded position.

[0016] FIG. 4 is a block diagram of the controls for a drive/disk combination employing the features of the invention.

[0017] FIG. 5 is a top schematic view showing an embodiment of an airflow unit with an inlet immediately upstream from a read/write actuator.

[0018] FIGS. 6A and 6B is a top schematic view showing another embodiment with a plurality of airflow units located in selected positions outside of the perimeter of a rotating storage disk.

[0019] FIG. 7 is a cutaway perspective view showing a different version of an airflow unit displaced from a head access hole in the cartridge.

[0020] FIG. 8 shows the structure of FIG. 7 from a side perspective view.

[0021] FIG. 9 is a top view of the structure of FIG. 7

Detailed Description

[0022] Generally speaking the invention provides inflow and outflow of air through a conditioning unit or units mounted in a storage cartridge installed in a disk drive. The size and location of the airflow units provides enhanced processing beyond that in ordinary types of re-circulation systems. Various elements can be included in the units including but not limited to filters, desiccants, chemical reaction packs, flow direction geometry and the like. In some embodiments the airflow through the conditioning units is driven in part by pressure differences generated the spinning storage disk, and also by the blockage created from the read/write actuator. All of the various features of the invention thereby provide greater protection and reduce the risk of media damage during rotation of the storage disk as well as during loading & unloading of the heads.

[0023] Referring to FIGS. 1A and 1B, an exemplary data storage cartridge 11 for incorporating an embodiment of the invention includes an outer shell or housing 12 with an upper half 14 and lower half 16 defining a head access opening 25 for receiving a linear actuator from a disk drive.

[0024] A data medium such as storage disk 20 and a hub 22 are rotatably mounted inside the outer shell 12. The head access opening 25 permits read/write heads from the drive to move back and forth along a radius R as the storage disk rotates, and thus be selectively positioned proximate upper and/or lower recording surfaces of the storage disk 20 for read/write accessing from and to the storage medium on the disk. A shutter 26 located along side edge 12a slides away from the head access opening 25 upon insertion of the storage cartridge into a disk drive. Otherwise the shutter is in a normally closed position

to protect the storage disk from contaminants or other undesirable interference or contacts.

[0025] FIG. 2 illustrates a different embodiment of an exemplary data storage cartridge 11 of the type for receiving a rotary actuator from a disk drive. The storage cartridge including a top shell 13 connected to sidewalls 15 and front wall 17, and including a bottom shell 9 connected to side walls 21 and front wall 23. The top and bottom shells are connected through a rear pivot 29 to form a drive head opening 25 when the shells are in open position for receiving a storage disk 27. (See United States Patent 6,268,982, which is incorporated by reference.)

[0026] Fig 3 shows an exemplary rotary actuator 31 with an actuator arm 35 holding a read/write head 42 in loaded position over a storage disk 27. A loading ramp 80 facilitates the loading and unloading movement of an actuator holding the read/write heads. A voice coil motor 30 enables rotary movement of the actuator to an unloaded position shown in phantom at 31a.

[0027] FIG. 4 schematically shows the various operational relationships for moving the actuator of the disk drive between a loaded and unloaded position. More particularly the voice coil motor 30 is coupled to the actuator 31 and is in electrical communication with a microprocessor 32 and a computer programmable memory 73 that has programmed code for controlling the operation of the microprocessor 32.

[0028] The disk drive has a mechanical or electrical sensor 74 to detect when a disk cartridge is inserted into the disk drive. An eject system 76 for ejecting the disk cartridge from the disk drive is activated by an eject button 80.

[0029] When a disk cartridge is inserted into the disk drive, the sensor detects its presence and communicates this information to the microprocessor. The programmed memory causes the microprocessor to power the voice coil motor so that the actuator is rotated from an unloaded position to a loaded position.

[0030] Reference is now made to FIG. 5, which illustrates an embodiment of the invention. A removable storage cartridge 11 comprises a data storage medium in the form a circular disc 27 housed within a cartridge housing 10. A drive head opening 25 in the housing 10 provides an access path to allow an actuator head to be moved back and forth into proximity with the storage medium 27. The actuator head 42 mounted on an actuator 31 is carried by a disk drive 8.

[0031] The storage medium is coupled by any suitable structure (such as through a hub) to a rotator or motor 18 in the drive 8 that rotates the storage medium in the removable cartridge. As the medium is rotated an air flow is created as shown by arrow 90. Due to blockage caused by the actuator head support assembly 31, a high pressure zone 91 is generated upstream of the actuator. Also due to the blockage, the high pressure zone helps to expel air from the cartridge as shown by arrows 92. Similarly actuator blockage creates a low pressure zone 93 downstream from the actuator that induces air inflow as shown by arrows 94. The airflows indicated by 92, 94 are mechanisms for air exchange between the cartridge and the drive and carry possible airborne contaminants.

[0032] The present embodiment includes an induction vent 95, preferably located near a high pressure zone, and an exhaust vent 96 preferably located near a low pressure zone. A conditioning system 50 is disposed in a passage 52 connecting the induction vent 95 and the exhaust vent 96. Air enters the induction vent 95 passes through the conditioning system 50 and is reprocessed and reconditioned. The reprocessed and reconditioned air is re-introduced at the exhaust slot vent 96. The air conditioning system 50 may include any suitable air conditioning, filtration, processing system, or the like.

[0033] Reference is now made to FIGS. 6A and 6B, which illustrate another embodiment of the invention. A removable storage cartridge 11 comprises a data storage medium in the form a circular disc 27 housed within a cartridge housing 10. A drive head opening 25 in the housing provides an access path to allow an actuator head to be moved back and forth into proximity with the

storage medium 27. The actuator head 42 is mounted on an actuator 31 that is carried by a disk drive 8.

[0034] The storage medium is coupled by any suitable structure to a rotator or motor 18 in the drive 8 to rotate the storage medium in the removable cartridge. As the medium is rotated an air flow is created as shown by arrow 90.

[0035] Referring to FIG. 6A, when the actuator is near an outer periphery 37 of the disk, the wake from the flow over the actuator results in dynamic pressure loss in the flow downstream of the actuator and produces a hydrodynamic blockage in a first recirculation filter unit at location 1L. However, a second recirculation filter or air-conditioning unit at location 1M is not in the wake for this perimeter actuator position and is still effective.

[0036] Referring to FIG. 6B, when the actuator is near a center portion 36 of the disk, the wake from the flow over the actuator results in dynamic pressure loss in the flow downstream of the actuator and produces a hydrodynamic blockage in the second recirculation filter unit at 1M. However, the first unit at location 1L is not in the wake for the center portion head position and is still effective. Consequently when the filter at location 1L is ineffective, the filter at location 1M is effective and vice-versa. The effectiveness of the filtration system is therefore less sensitive to actuator position by using such plurality of filter units uniquely located.

[0037] A similar scheme applies at the drive level as well. When the actuator is near the center, airflows in and out of the cartridge are set up as shown at locations 1N and 1P, for first and second filters, respectively. The flow direction at 1N and 1P is dependent on actuator position on the disk, so drive level filters can complement each other at locations 1N and 1P for different actuator position similar to the previously described filter unit positions.

[0038] Reference is now made to FIGS. 7, 8 and 9, which show another embodiment of the invention. Shown is only a portion of a cartridge of the invention. In this embodiment, a filter or air conditioning unit with an enlarged

inlet 98, and an upwardly oriented filter outlet 99 is mounted in a cartridge that has a housing 10 with a head access opening 25.

[0039] The cartridge has a circular storage medium 27 (shown in part in FIG. 9 and FIG. 10) with a center 36, a periphery 37, and a data storage surface 38. The medium 27 may have a storage surface on both sides 38. The storage medium 27 is protected within the housing 10. Referring in particular to FIG. 10, the housing 10 is structured to provide an access path through access opening 25 to allow the head 42 of the actuator 31 to be moved back and forth into proximity with the data storage surface 38 of the medium. The storage medium 27 is rotated by a drive rotator or motor 18 around the center 36 when the removable cartridge is mounted in the drive.

[0040] The housing 10 includes a panel 19 that is generally parallel to and extending over the storage medium 27. Rotation of the storage medium induces an air flow in the direction of rotation 90 over the data storage surface of the medium. An air processing or conditioning unit 50 is located across the air flow in at least part of the region between the center 36 and the periphery 37 of the rotating medium 27 and between the data storage surface 38 of the medium 27 and the panel 19. Only one panel 19 and conditioning unit 50 is shown, but there may a panel and conditioning unit associated with the other data storage surface 38. Preferably, the air processing unit is directed over most of this region with where the air processing unit extends between a location near the center and a location adjacent the periphery of the rotating medium and extends between a location adjacent to the data storage surface of the medium and a location adjacent to the panel.

[0041] To increase the particle capturing surface of the filter and minimize the tendency of particle laden air to flow around the conditioning unit, the air processing unit is preferably angled, preferably with a leading edge 97 directed in a direction into the air flow at the location adjacent the surface of the medium.

[0042] In any embodiment of the invention, variously shaped and sized airflow conditioning units can be incorporated for use with variously sizes and shapes of storage disks installed in different orientations with a disk drive in order to enjoy the benefits of the invention. It is believed that the direction control of air passing through the airflow units helps to diminish the air exchange from outside the cartridge. In this regard, structures in air flow path, such as induction and exit vents, flow passages, cartridge and drive walls, may include aerodynamic contours to help handle and direct air currents efficiently. Any of the aspects or embodiments of the invention can be used alone or used with other aspects or embodiments of the invention or other air conditioning/filtering systems for more effective air conditioning and filtering.

[0043] While this invention has been described with reference to certain specific embodiments and examples, it will be recognized by those skilled in the art that many variations are possible without departing from the scope and spirit of this invention, and that the invention, as described by the claims, is intended to cover all changes and modifications of the invention which do not depart from the spirit of the invention.